Thomas Burton Kinraide and the development of commercial high frequency coils

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Historian and inventor
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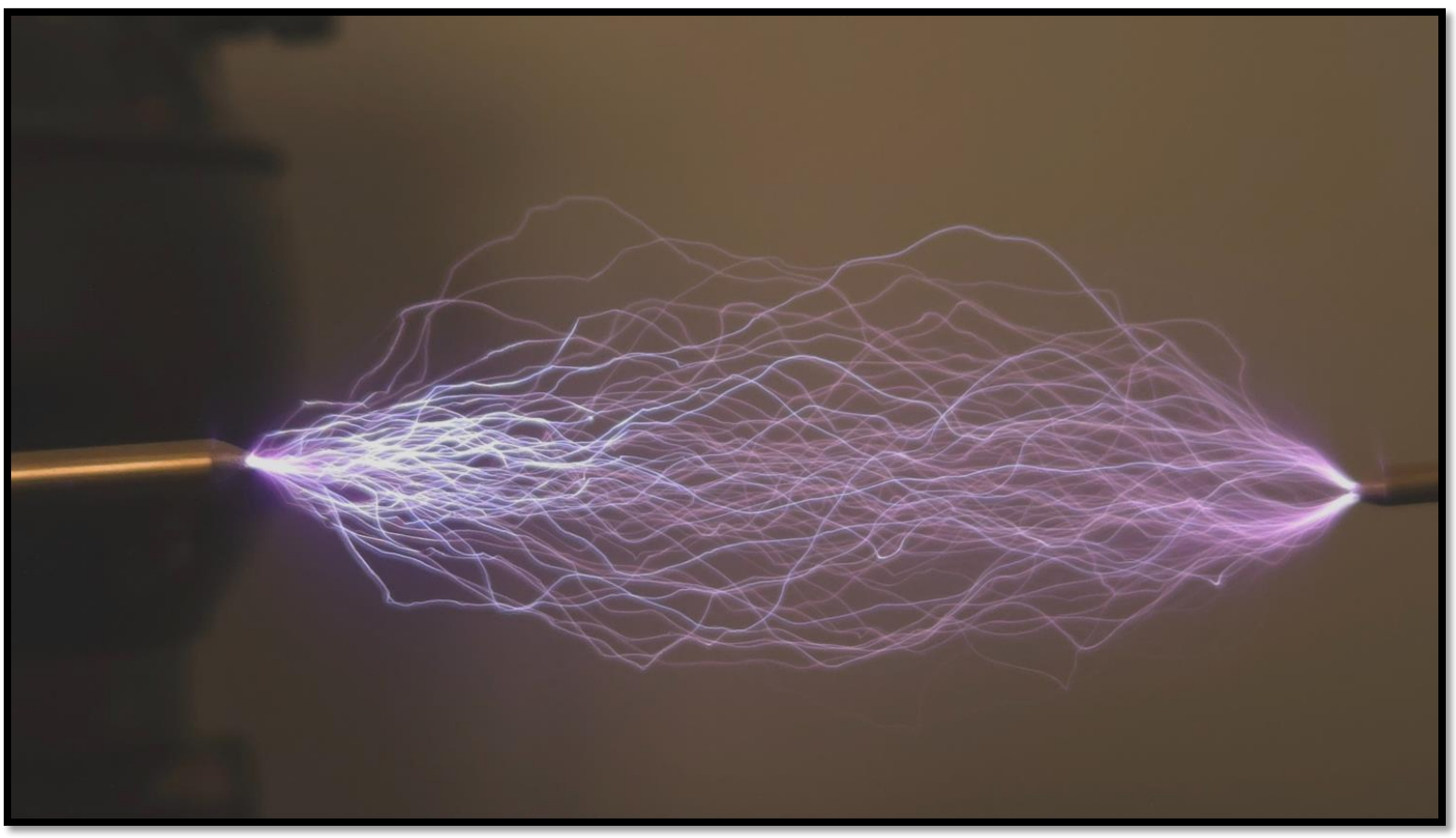
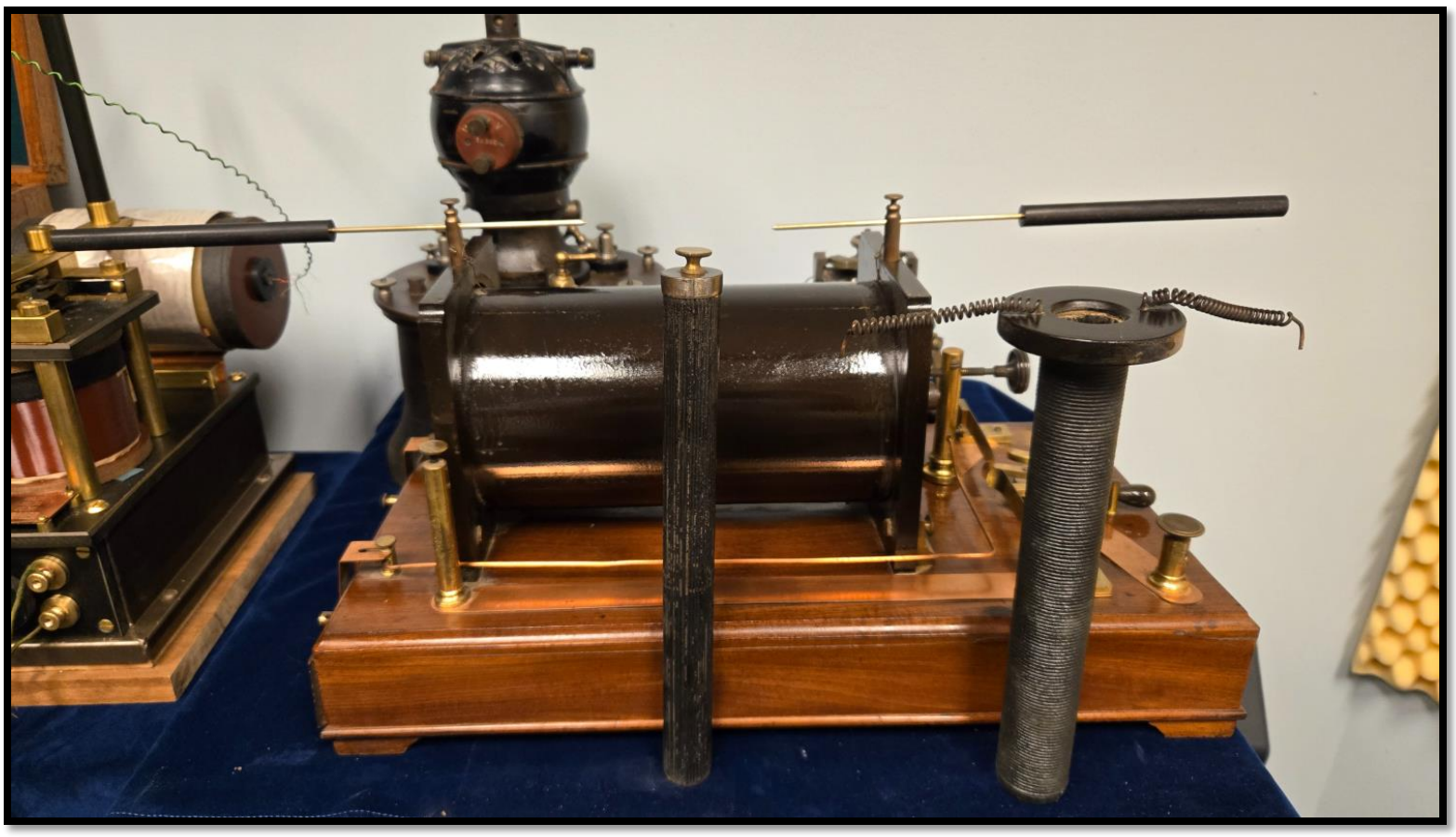
While most people think of the pioneer of high frequency coils as Nikola Tesla, there were several people working independently on solving similar problems in the 1890s. Elihu Thomson was one, Nikola Tesla was another... and in the suburbs of Boston - in Jamaica Plain Massachusetts there was yet a third man who was known by both - Thomas Burton Kinraide.



Discharge from John W. Queen Induction Coil.



J. W. Queen Coil, showing primary coil and soft iron core removed.

Kinraide had a hobby of studying and photographing electrical discharges at a time when electricity was still not-well understood. He did this in dark cavelike rooms which were hidden beneath his 25-room mansion in Jamaica Plain, Massachusetts - a house he referred to as Ravenscroft. During the course of this experimentation, he often burned out expensive induction coils - many of which had 5 miles or more of fine 36 AWG wire laboriously wound in as many as 96 sections. It was from here that Kinraide started new research into improving this style of coil.

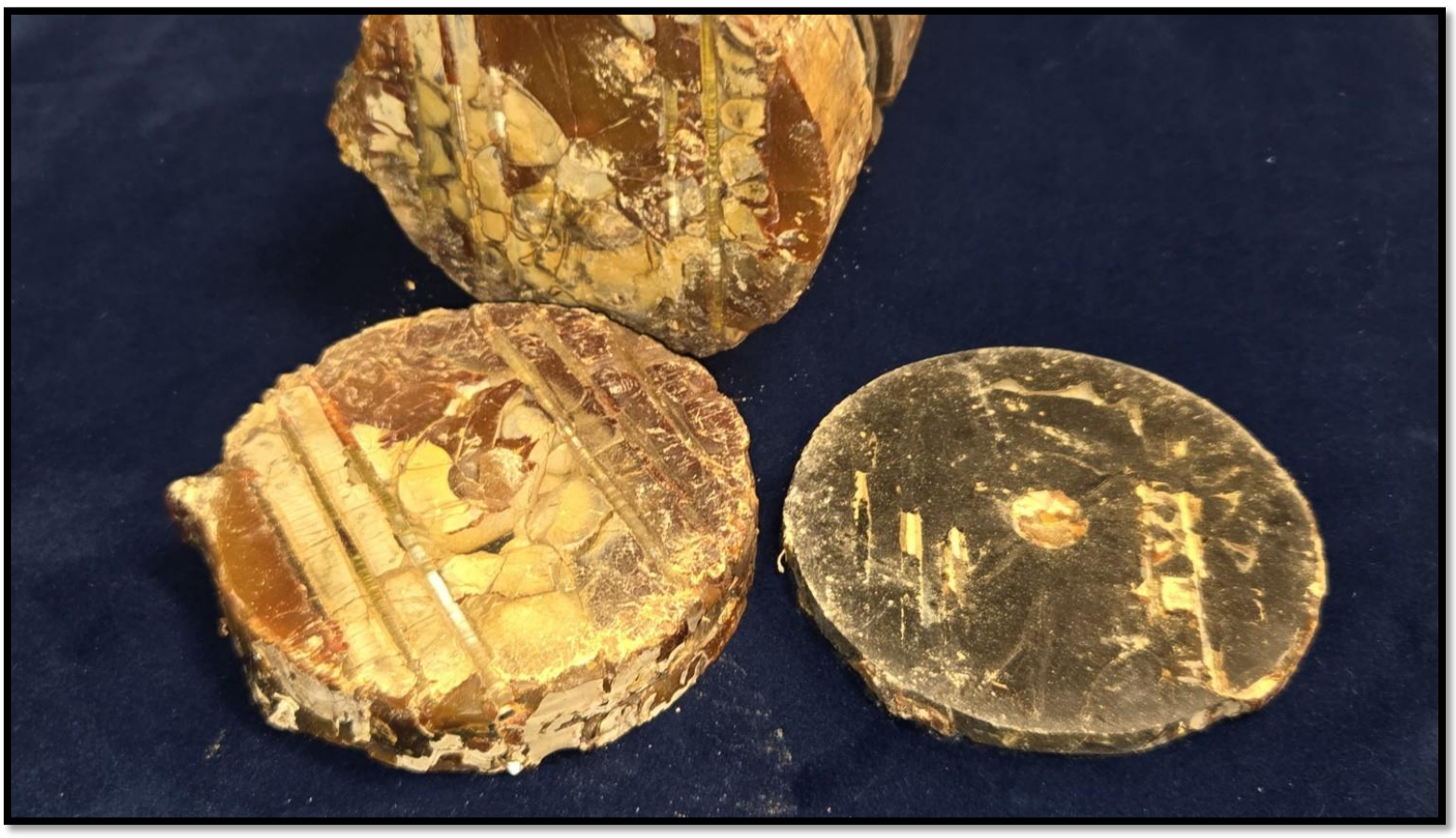
One of several rooms hidden beneath Kinraide's eccentric home, Ravenscroft. It was here that he did much of his electrical researches.

Secondary Coil of induction coil disassembled by Kinraide showing primary insulation tube and a single pair of clockwise and counter-clockwise coils glued back-to-back using beeswax and rosin, insulated between layers using thin ebonite disks.

Closeup of disassembled induction coil secondary coil, many of these disks were placed in series and wound opposingly to produce the high voltage sparks needed for experimentation.

Remains of the earliest development of high frequency coils

Kinraide started off his research not unlike Tesla and Thomson. He took the concept of the induction coil and simply used less sections of wire and thicker insulation to be able to operate them at a higher voltage using capacitor-discharge circuits.



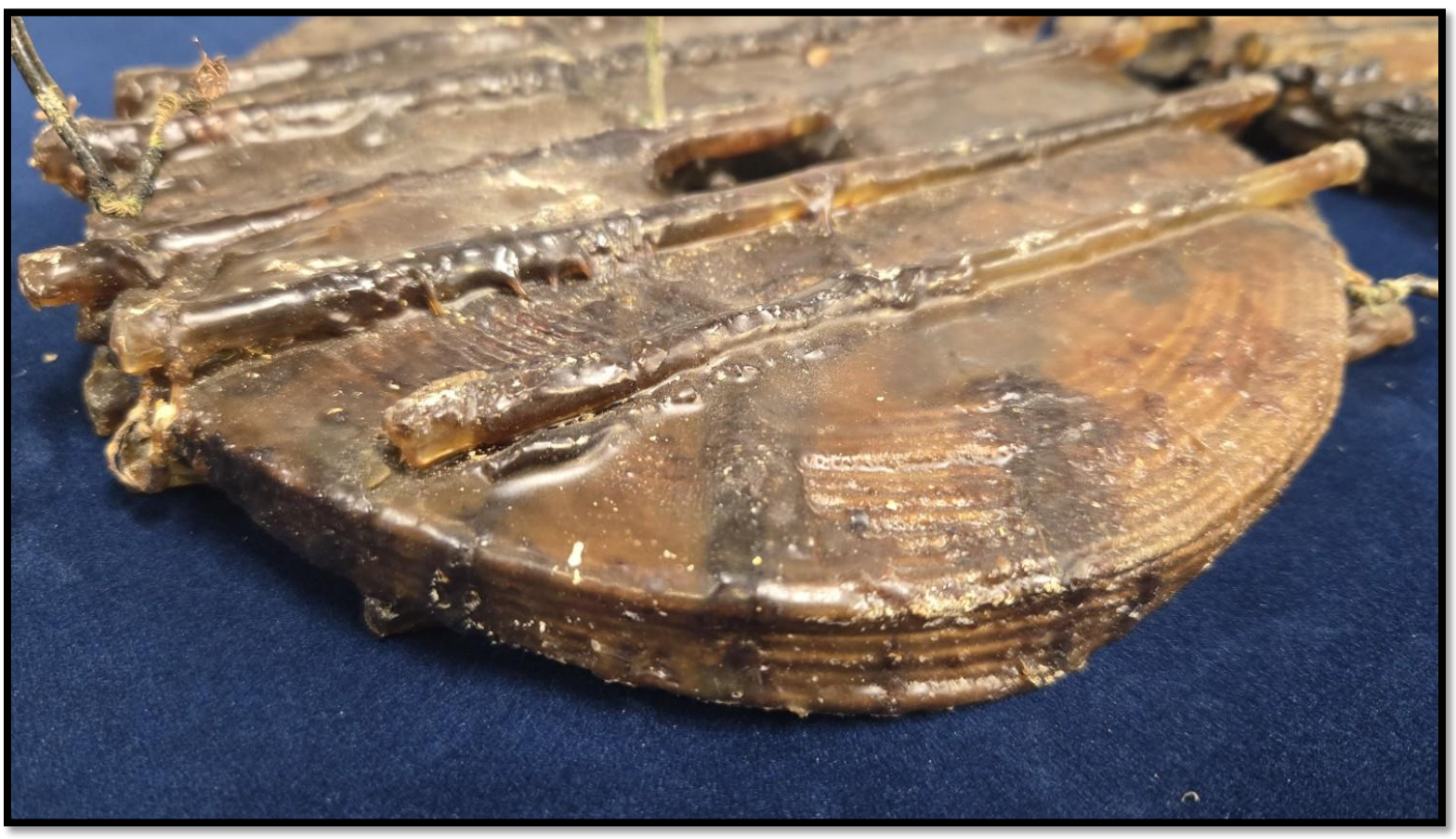
Thicker high frequency coil sections and insulating disks

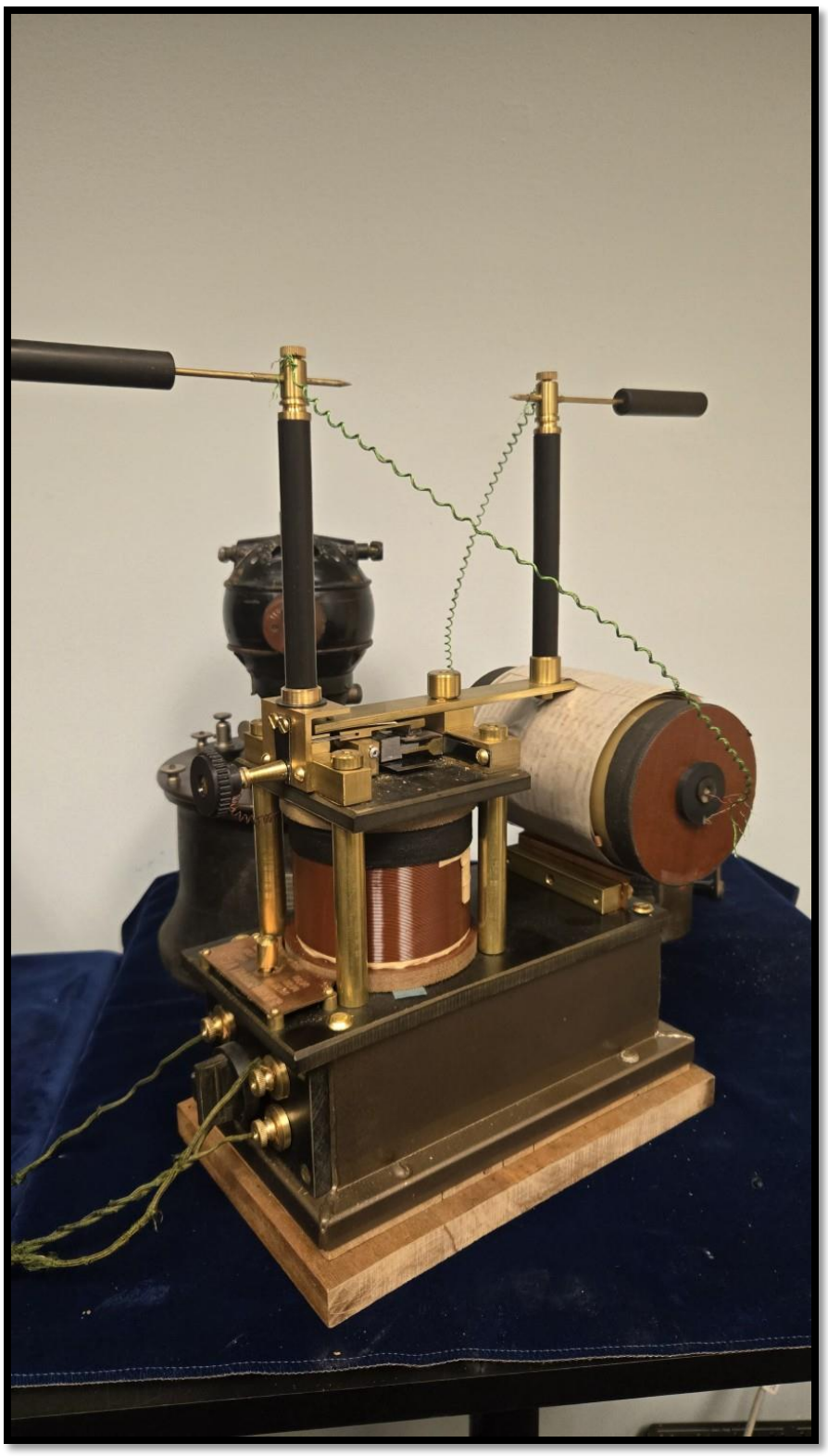
Coil sections used glass rods to mechanically sandwich the windings, something Kinraide would later file a patent for.

Insulating this type of coil proved difficult, and also like Tesla and Thomson his original coils were under oil (kerosene) - which was messy and provided hazards when the boxes leaked.

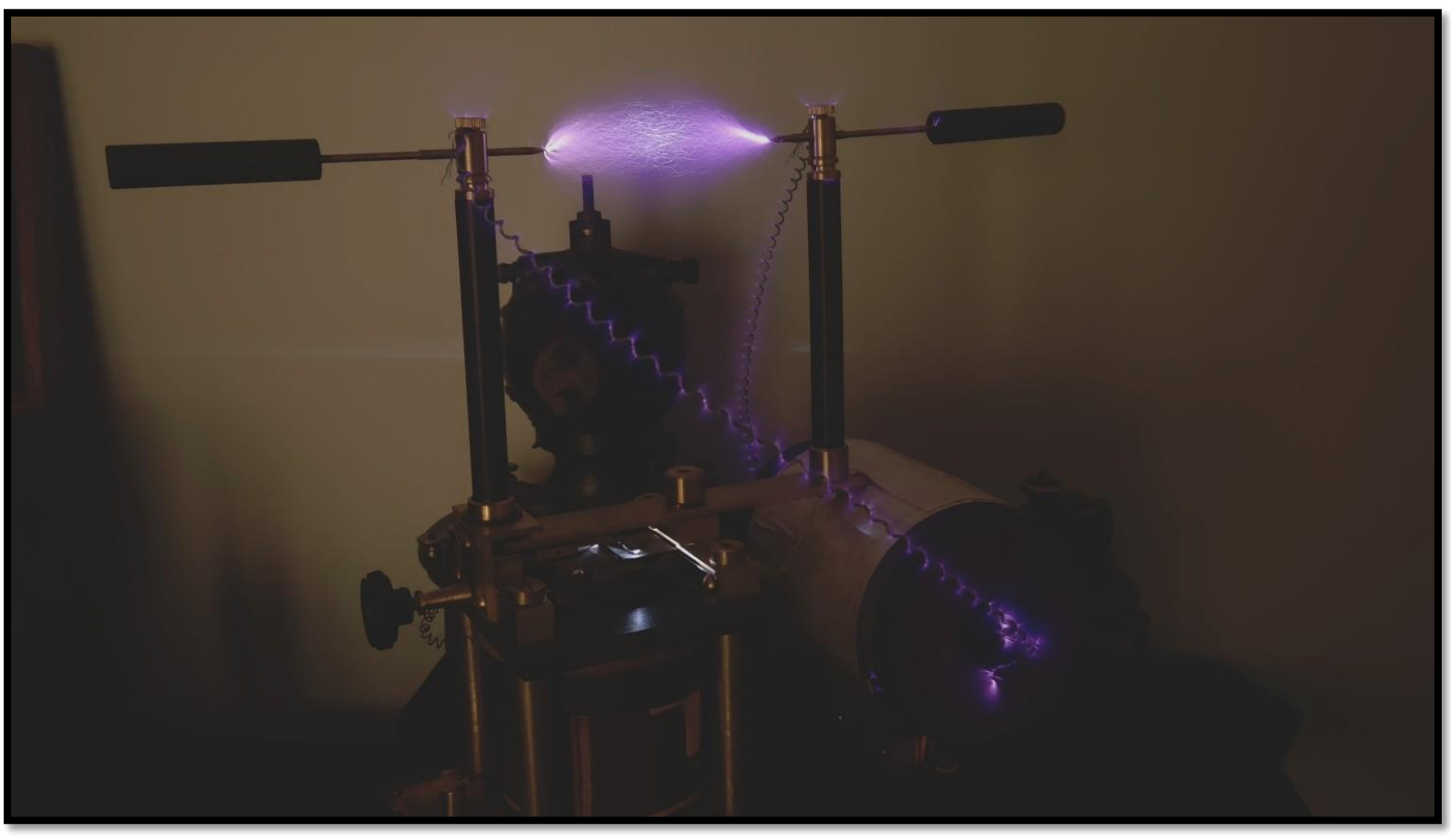
The next development in Kinraide's design was to increase the diameter of the coils and use only 2 of them.

This development allowed for solid insulation instead of oil (also beeswax and rosin) and by placing the coils side-by-side preventing the typical electrical stresses between sections (in addition to parasitic interference of one coil to the next) in closely-coupled scenarios. This offered an improvement over both Tesla and Thomson's designs, and in the emerging X-Ray market allowed for an oil-less design which was easier to transport.

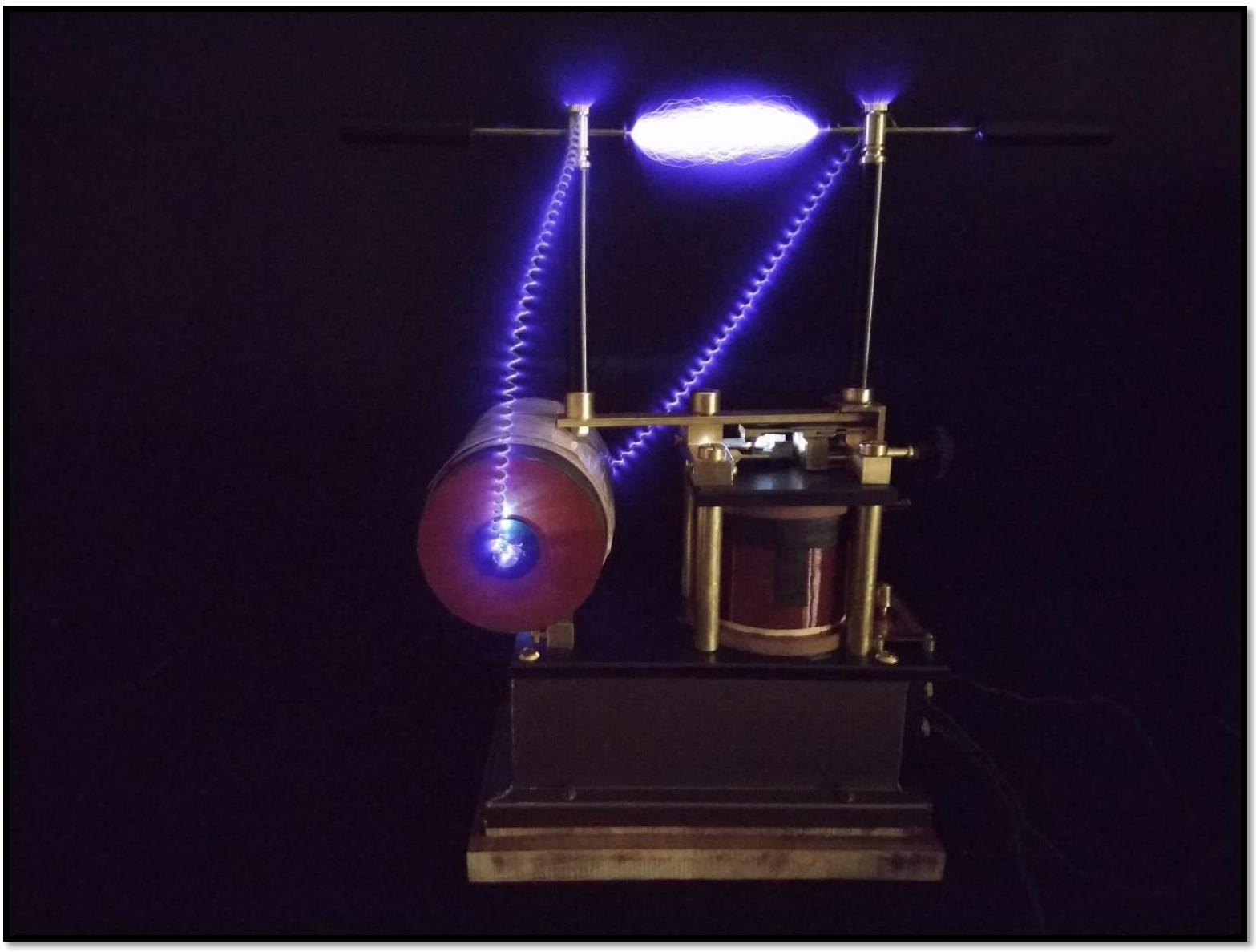




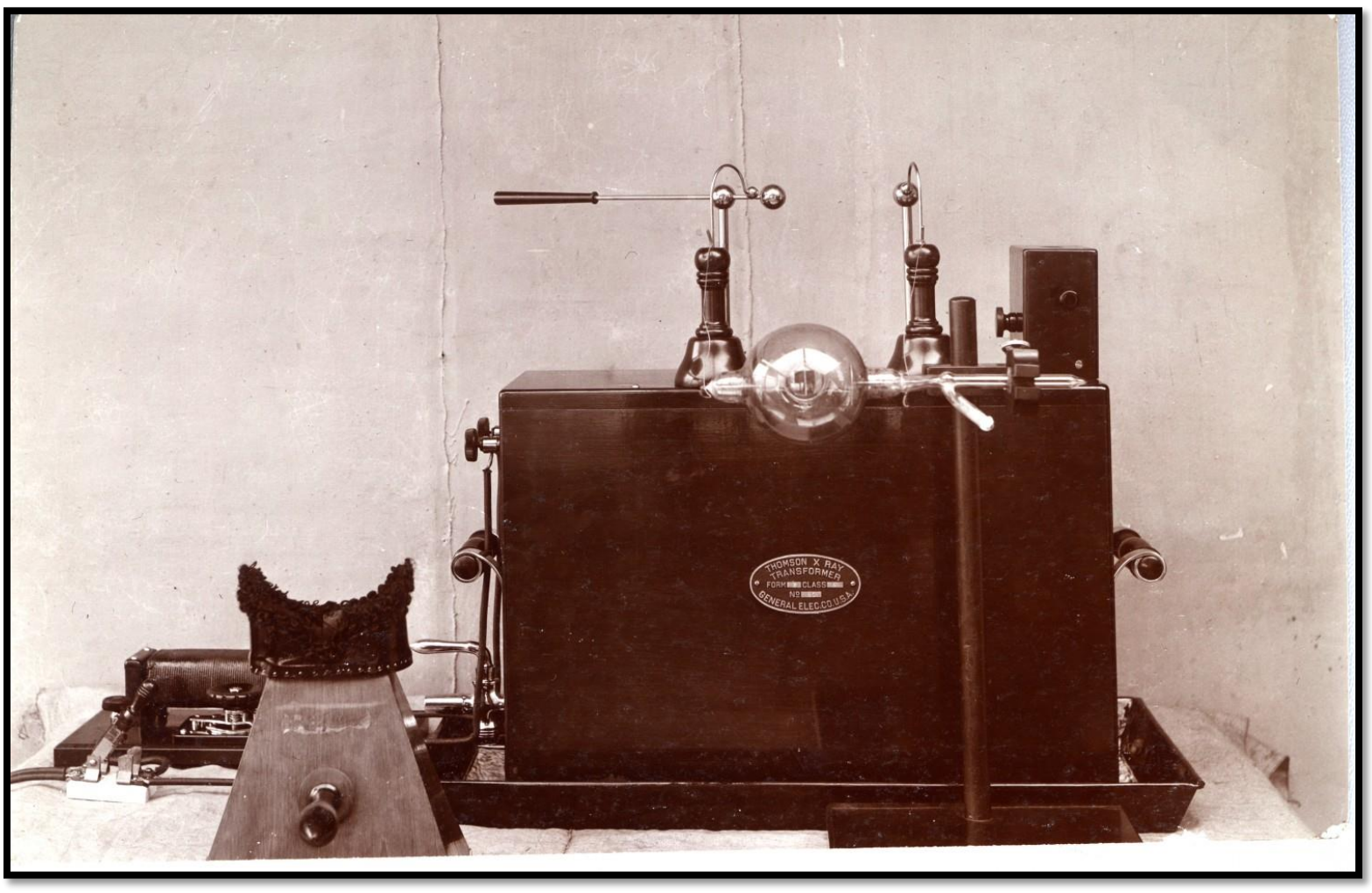
Tesla Tabletop Oscillator, having secondary coils back-to-back.



Discharge from Tesla's Oscillator



The terminals to Tesla's coils were removed from the high frequency coil, proving difficult to insulate because of corona discharges.



Elihu Thomson Coil, Courtesy of Chris Hunter from The Museum of Innovation and Science

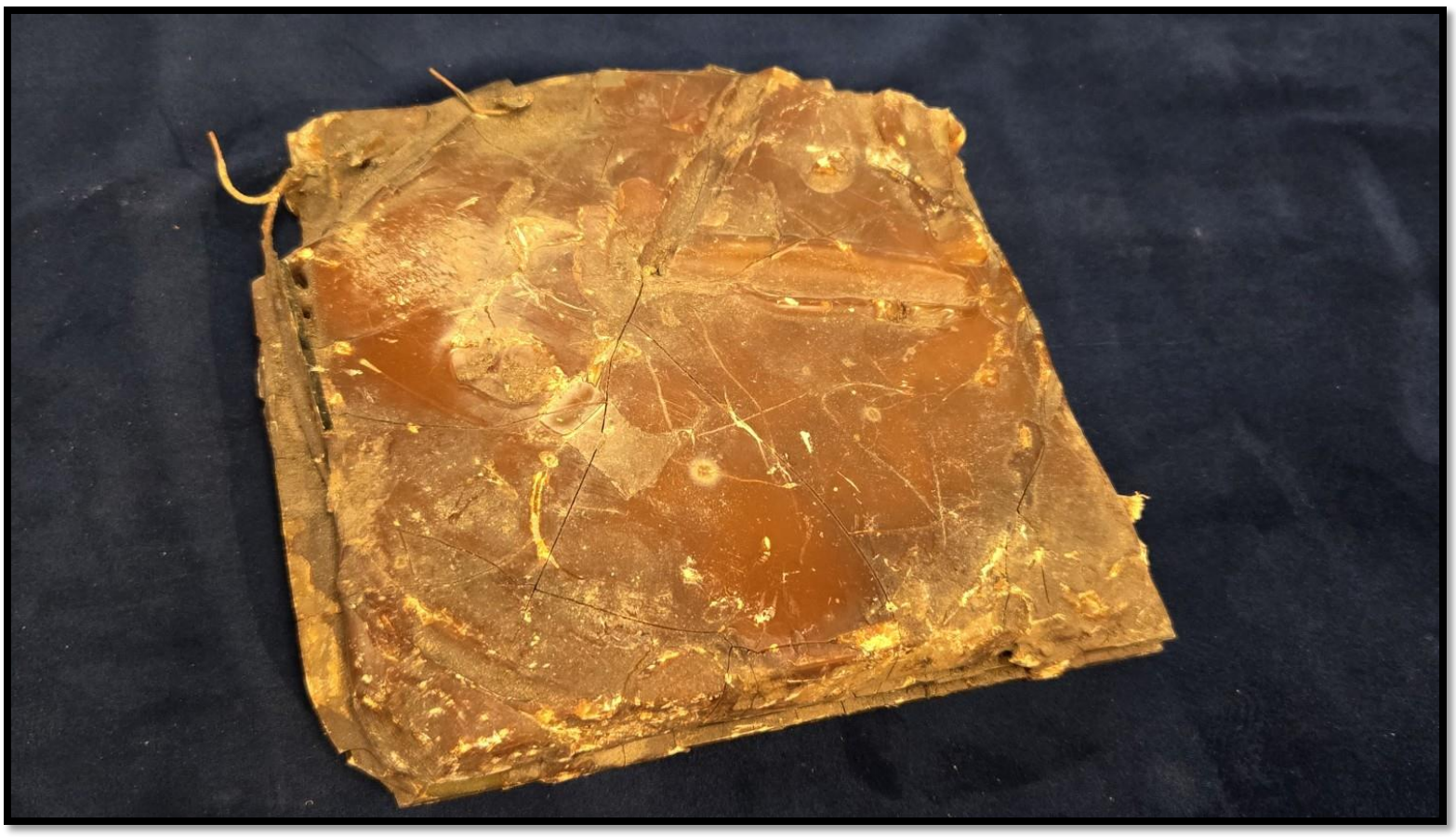
Thomson's Coil was perhaps the first commercial high frequency coil that used oil-insulated single-layer air-core coils. The frequency was very high and efficiency was likely low due to low currents in the spark gap and charging circuit.

Similar single-layer coil from Swett & Lewis

This coil was an inexpensively distributed high frequency coil that could be operated from static machines or induction coils. Efficiency on this coil is very low for X-Ray use but can be used to light wireless lamps and kindred experiments.

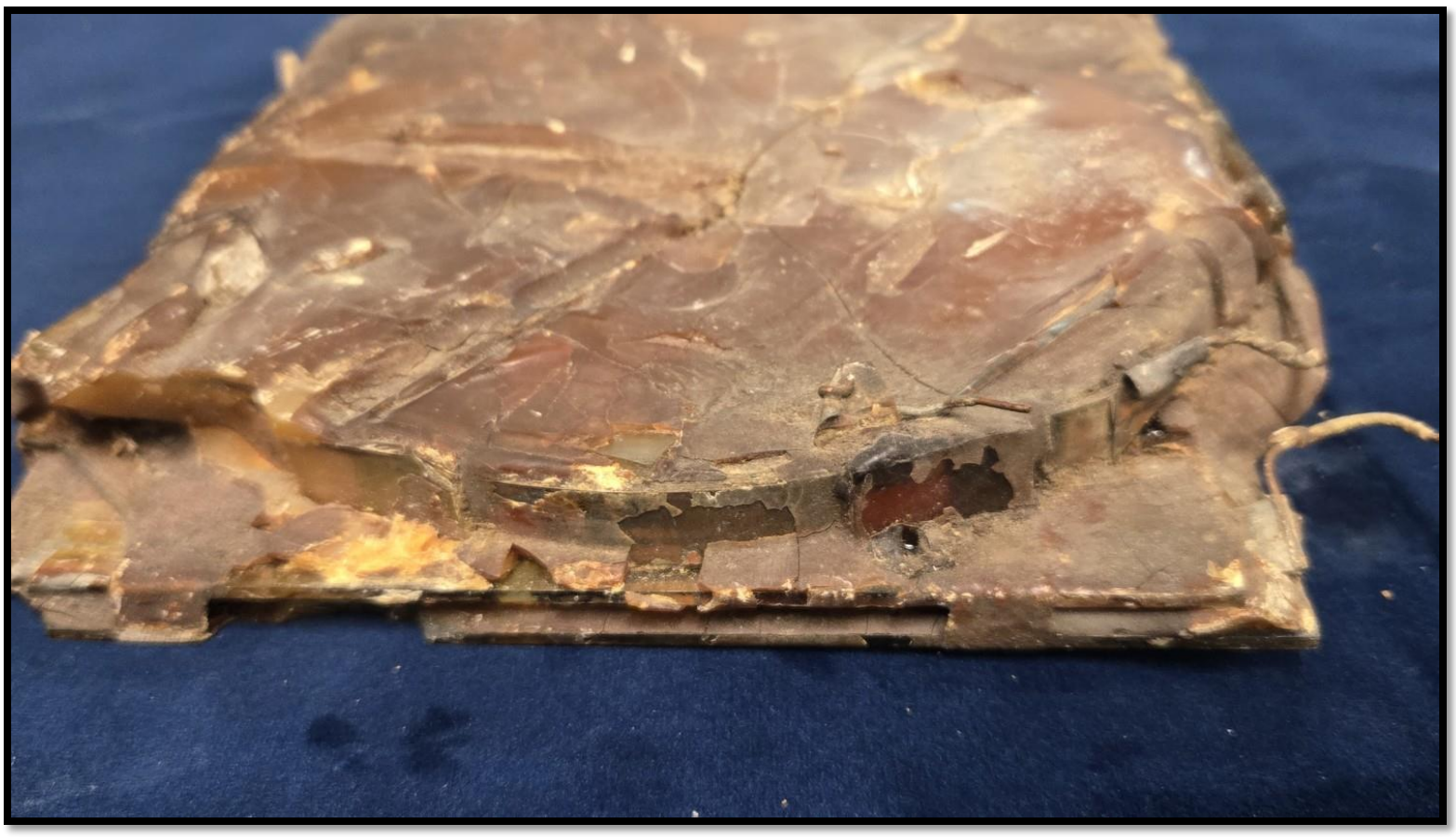
Other design of Kinraide prototypes

It is obvious Kinraide had to experiment with layer thickness and quantity of windings to get the best results of resonance while maintaining safe insulation with the solid wax mixtures.



Another prototype coil that combined the flat "pancake" primary and secondary coils with a capacitor.

Bottom view showing capacitor.



The operating voltage of this coil would be greatly limited due to the close proximity of the capacitor.

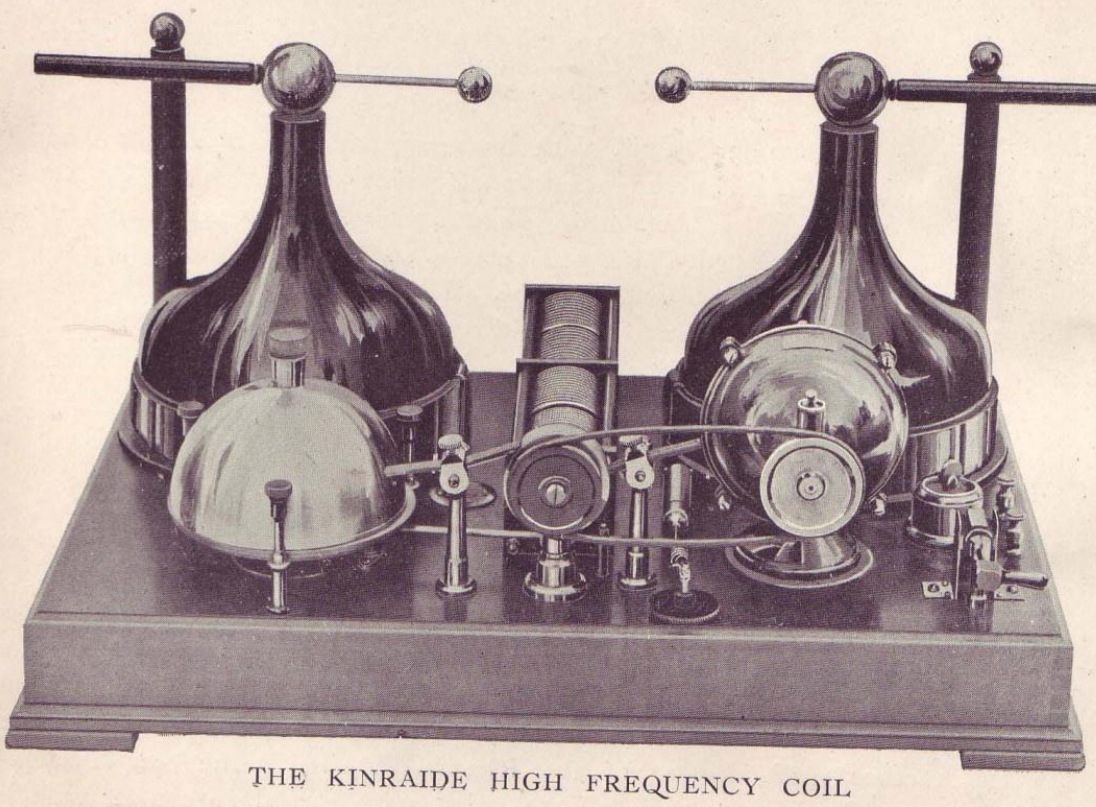
The later stages of Kinraide's high frequency coil development included ebonite (hard rubber) coil forms to provide maximum insulation against break-downs.

This later changed to included custom molded hard rubber housings that contoured to follow the electrical stresses as the voltage increased to the center windings of the coils.

Showing prototype coil unmolded from housing.

Showing the flat coil before insulation.

Showing the high frequency X-Ray tube used with Kinraide's coils.



THE KINRAIDE HIGH FREQUENCY COIL

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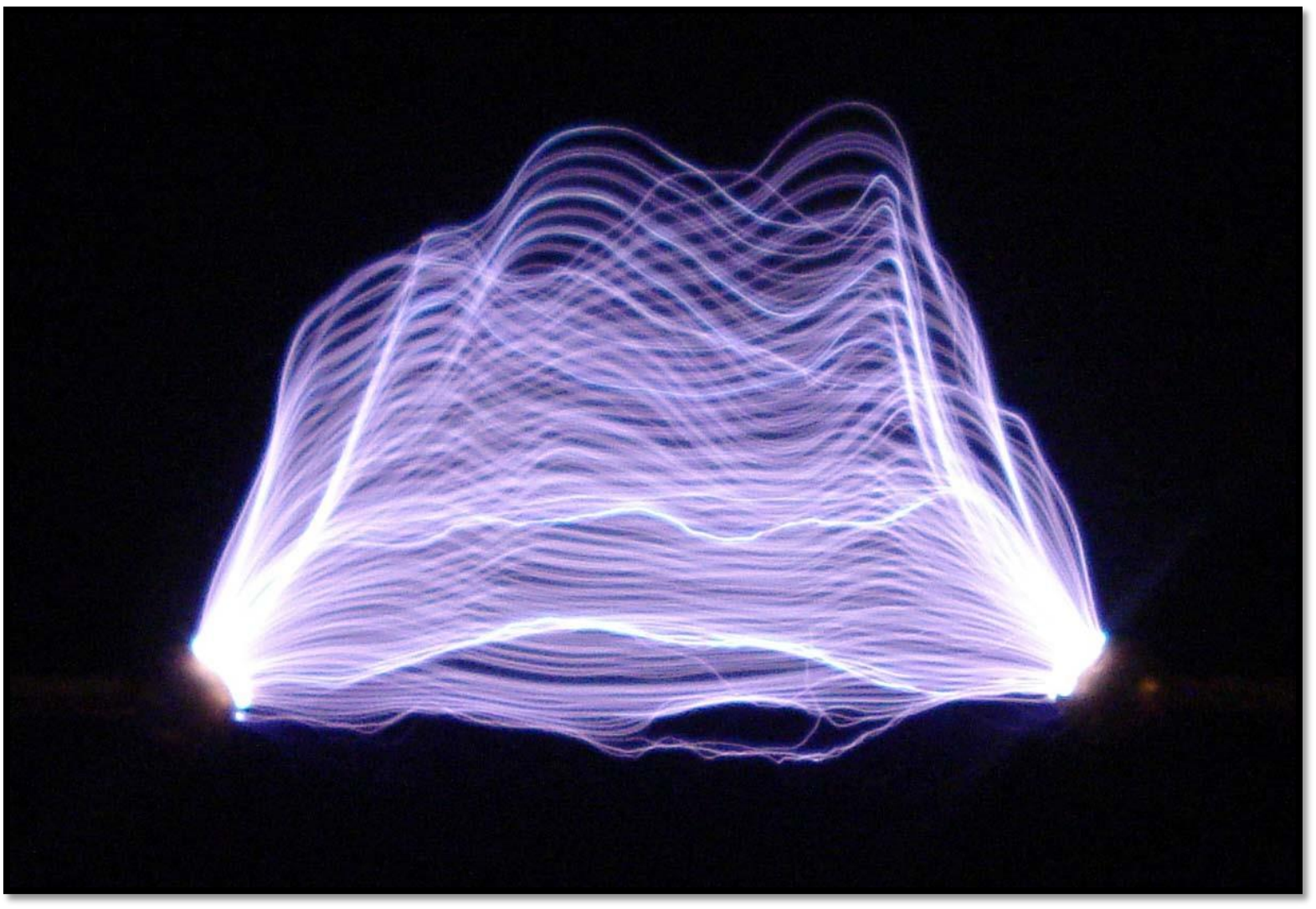
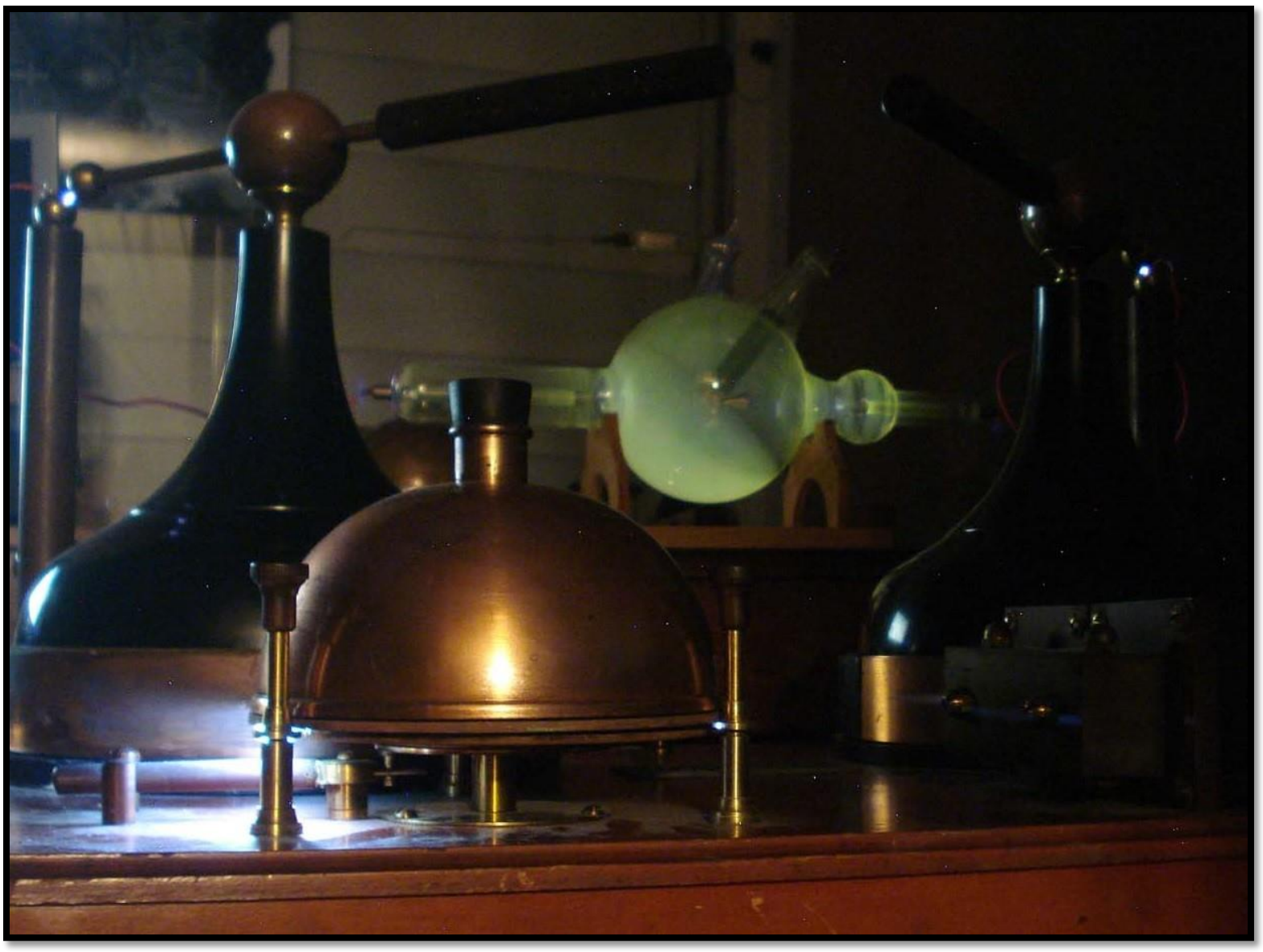
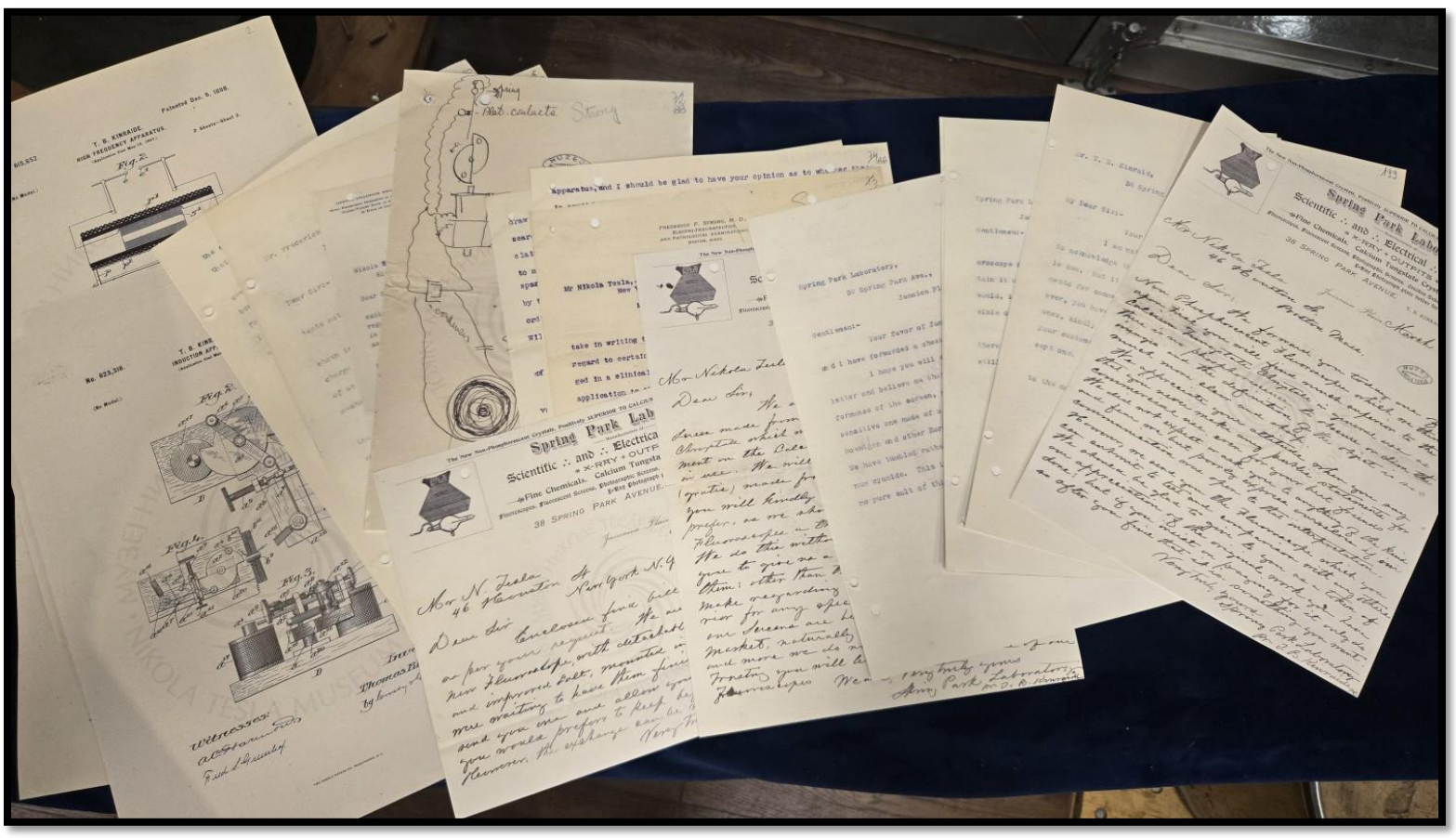
From an early catalogue of the Swett & Lewis company, who sold Kinraide products.



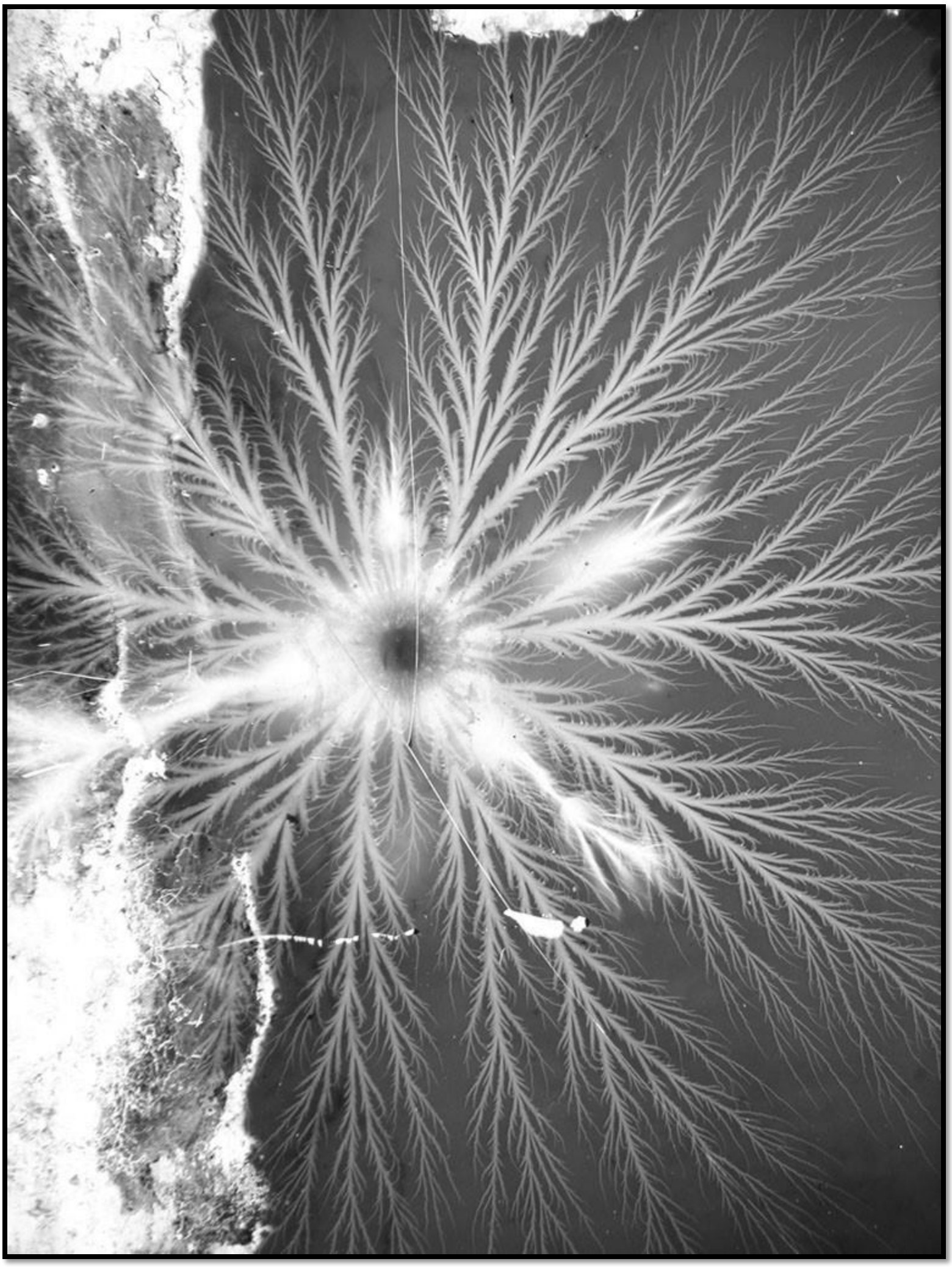
Discharge from Kinraide Coil



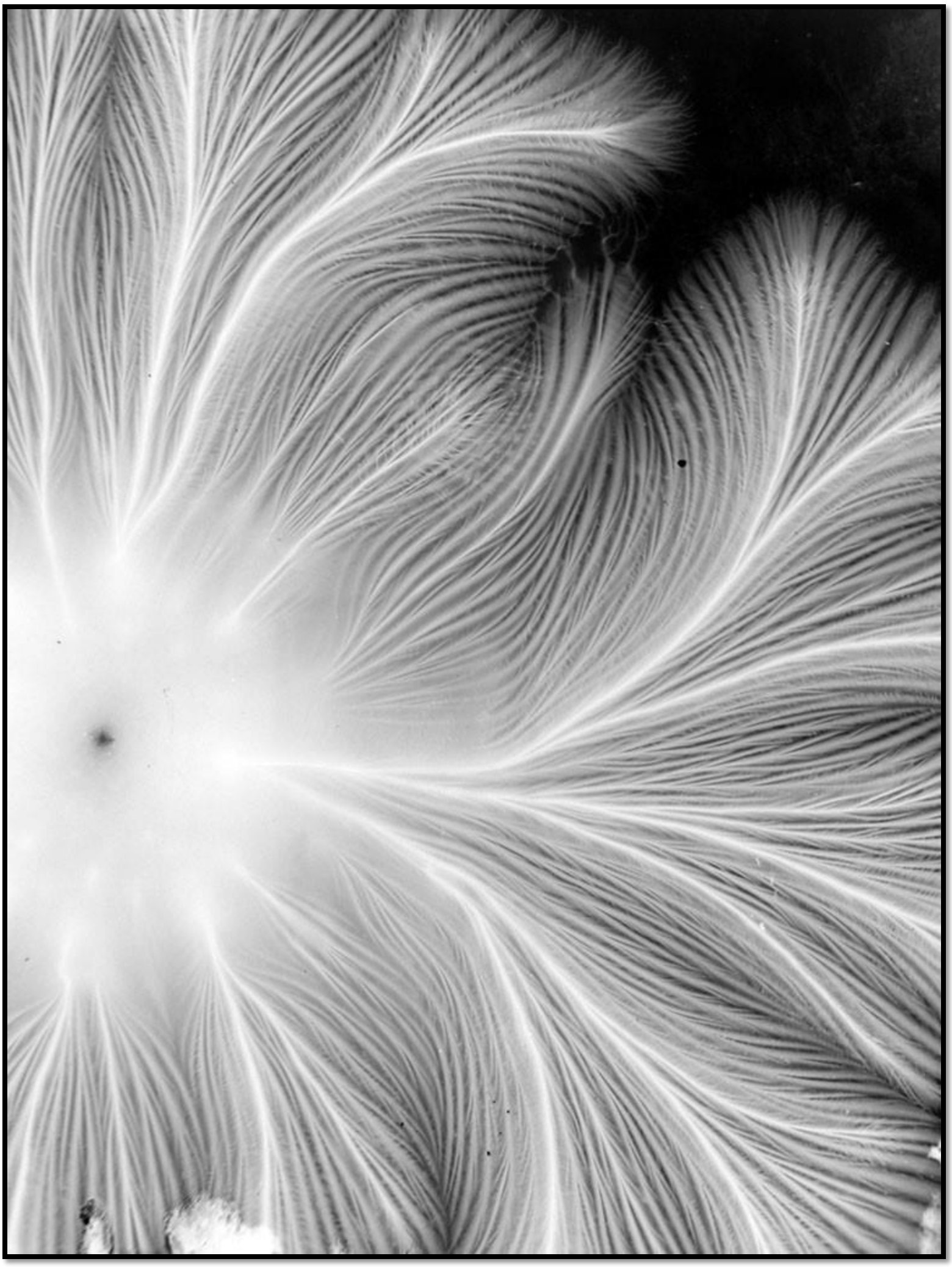
Running an X-Ray tube with Kinraide Coil. Original machine restored for the Kinraide family by the author.



Letters to and from Nikola Tesla and Thomas Burton Kinraide from Nikola Tesla Museum in Belgrade.



Original 11" x 14" electrograph, showing positive electrical discharge from Kinraide Coil.

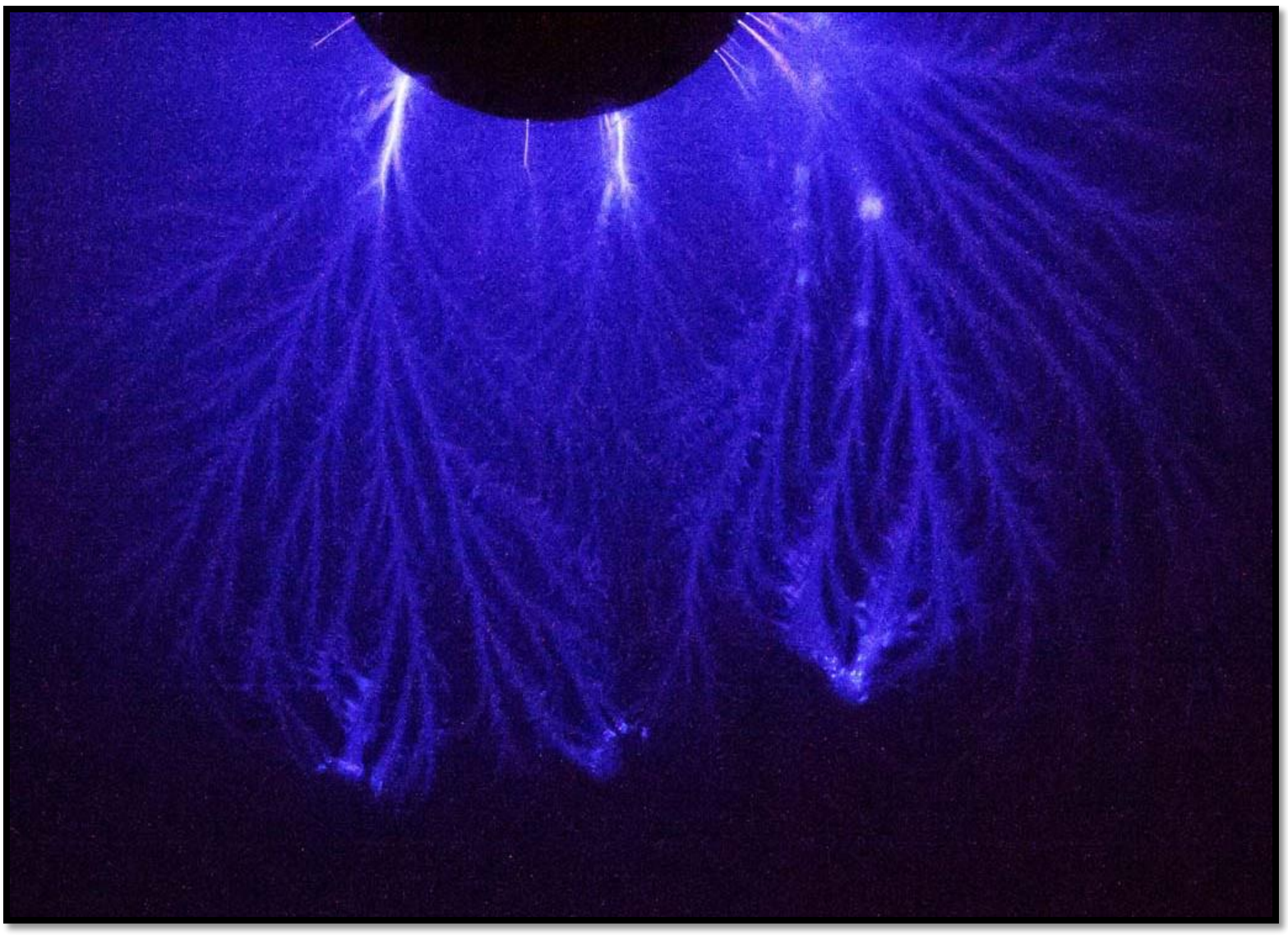


Original 8" x 10" electrograph, showing negative discharge from Kinraide Coil.

While Kinraide's 1890s work may be nearly all but forgotten, the technology still holds valid today for researchers.

Discharge of high frequency coil based on Kinraide's design, made by the author.

The electrical discharges from Kinraide's coils provide not only pleasing aesthetics for studying artistically the structure of electrical discharges, they have also been shown to replicate upper-atmospheric phenomena such as Sprite lightning.



The author holds a patent for replicating upper atmospheric phenomena based on concepts original pioneered by Kinraide, refined using modern materials and electrical discharge apparatus. Photo by Kelly McJilton.

Play

Video showing continuous discharges of Kinraide Coil replica using less than 120 Watts of power at 120VAC. Voltage is approximately 250kV.

The coils and apparatus seen in this article are the oldest-known high frequency coils in the United States and can be seen in person by visiting the Turn Of The Century Electrotherapy Museum in person or at the link below:

www.electrotherapymuseum.org

The author is the museum's curator and this year the museum celebrates its 30th year.